India and space

After MOM's success, ISRO's focus shifts to sending astronauts into space. BY **T.S. SUBRAMANIAN**

AFTER the phenomenal success of the Mars Orbiter Mission (MOM), the Indian Space Research Organisation (ISRO) has turned its attention to the maiden flight of its biggest launch vehicle so far—the Geosynchronous Satellite Launch Vehicle Mark III (GSLV-MkIII)—in November.

The 630-tonne GSLV-MkIII will carry a 3.65-tonne crew module in which ISRO plans to send astronauts into space eventually. When the vehicle becomes operational after three successful flights in a row, India will become a major player in the competitive commercial launch market for putting four-tonne communication satellites into orbit.

ISRO now has the capability to build any type of launch vehicle and any type of satellite. Its launch vehicles can put these satellites into any type of orbit from its own spaceport at Sriharikota in Andhra Pradesh. It successfully put a navigation satellite into orbit as recently as October 16. In January 2007, it put into orbit its first Space Capsule Recovery Experiment and recovered it after 12 days from the Bay of Bengal. ISRO is self-reliant in propellants too and uses its own solid, liquid and cryogenic propellants in its launch vehicles.

Future missions and technologies

1 **GSLV-MkIII** (42.4 metres tall; 630 tonnes lift-off weight): This is the biggest launch vehicle the Vikram Sarabhai Space Centre (VSSC) in Thiruvananthapuram has built so far. The debut flight of this three-stage vehicle in November 2014, carrying a crew module, will be a suborbital mission. It will last 1,109 seconds and reach a height of 126 kilometres, where the crew module will get separated from the rocket and return to the earth in the sea off the Andaman archipelago. Control systems on board the crew module will slow down its descent into the atmosphere and huge parachutes will spread out in sequence to enable its splashdown in the Bay of Bengal. A young team of VSSC engineers has built the crew module and the Aerial Delivery Research and Development Establishment, a unit of the Defence Research and Development Organisation, in Agra, has developed the parachutes. ISRO's Human Spaceflight Programme aims to send two astronauts into a low-earth orbit and bring them back safely to a predetermined destination on the earth.


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1. A mock-up of the GSLV-MkIII on the second launch pad.
2. The crew module. 3. Inside the crew module.

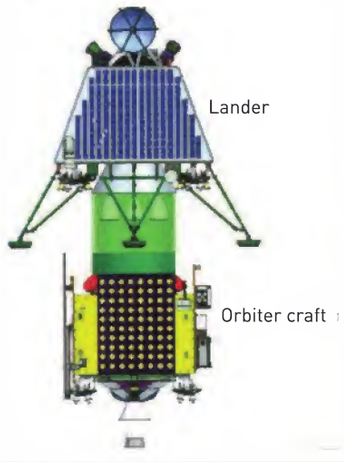
Since 1979, when it launched the SLV-3, ISRO has sent up its launch vehicles 43 times: four SLV-3s, four Augmented SLVs, 27 Polar SLVs and eight Geostationary SLVs. These vehicles have, in all, put into orbit 38 Indian satellites used for remote-sensing, communications, weather-watching, navigation, and so on. The PSLV has also put 40 foreign satellites into orbit.

Antrix, the commercial wing of the Department of Space, charges $25,000-30,000 a kilogram of payload for putting foreign satellites into orbit.

Source: ISRO

2 **Chandrayaan-II:** The mission will consist of an orbiter, a lander and a rover. GSLV-MkII, with India's own cryogenic engine, will put Chandrayaan-II into orbit in 2017. After the lander touches down on the surface of the moon, the rover will roll out from the lander and go about the moon's surface conducting experiments. The data will be beamed back to the earth.


The six-wheeled Rover in testing. (Below) An artist's impression of Chandrayaan-II.



3 **Reusable Launch Vehicle** - Technology Demonstrator: This is the Indian version of the U.S. space shuttle. Its debut flight will take place in a few months. The winged RLV will ride on top of one of the strap-on booster stages of the PSLV; it will be released at a height and will glide down to make a splash-landing in the sea.


The proto-model of the RLV-TD

4 **Unified Launch Vehicle:** This is ISRO's next generation heavy-lift vehicle. It can put a 10-tonne satellite into the geostationary transfer orbit. It may have two solid strap-on booster motors, each fed by 300 tonnes of solid propellants, a core liquid stage and an upper cryogenic stage, which will be propelled by 200 tonnes of semi-cryogenic propellants. Configuration studies are under way.

5 **Air-breathing propulsion project:** Air-breathing rocket systems use atmospheric oxygen to burn the on-board fuel to generate the forward thrust unlike conventional chemical rocket systems which carry both the fuel and oxygen on board. Since air-breathing propulsion systems do not carry the oxidiser with them, they can put heavier satellites into orbit. ISRO has already realised a supersonic combustion ramjet engine, which is an important development in air-breathing propulsion.

6 **Semi-cryogenic engine project:** This envisages design and development of a 2,000-newton semi-cryogenic engine to launch the ULV and the RLV. The semi-cryogenic engine will use a combination of liquid oxygen and ISROSENE (propellant-grade kerosene, developed by ISRO). ISRO received the first semi-cryogenic engine hardware, made by ASACO, Hyderabad, on October 14. The engine components and subsystems will soon be developed and subjected to endurance tests.

7 **Space Capsule Recovery Experiment (SRE-2):** After the SRE-3 is put into orbit, it will become a platform to conduct micro-gravity experiments. It will return to the earth a few days after its launch and will be recovered. Like the SRE-1 in 2007 and the passive GSLV-MkIII mission, this is a forerunner to India sending its astronauts and bringing them back. The SRE-2 will prove the re-entry technology.

The aerothermo structure, an important part of SRE-2.